Collider Run II Shot Setup Documentation

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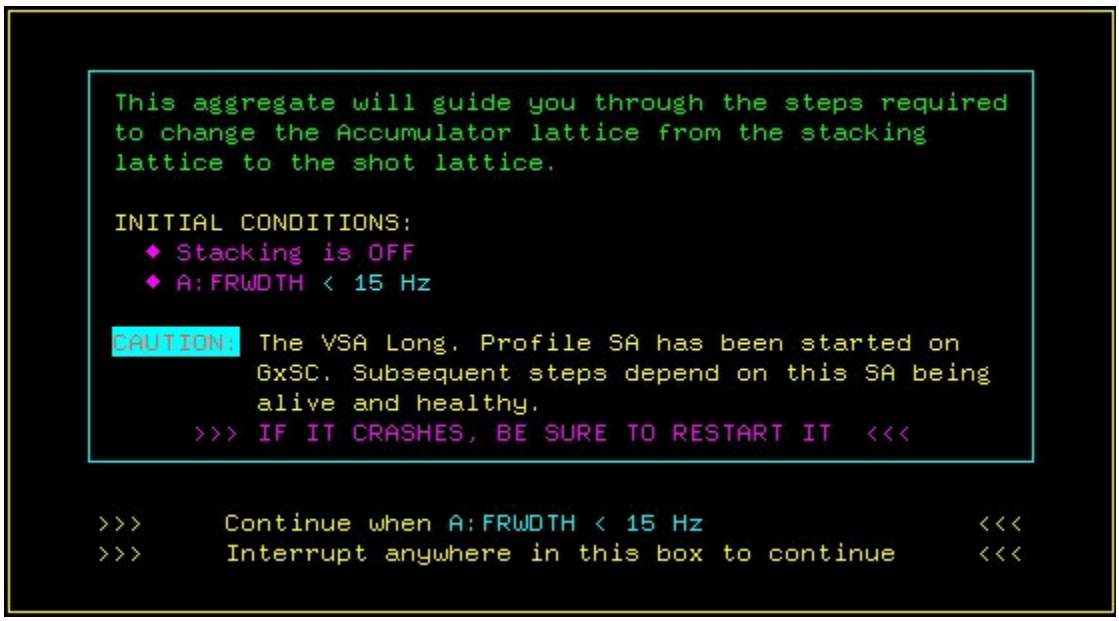
Send suggestions and comments to ad-pbar-tuning-adminNOSPAM@fnal.gov (remove "NOSPAM")

Sequencer: Pbar
Collider Aggregate: **Run II Switch to Shot Lattice**
Previous Aggregate: Run II Start Reverse Protons
Purpose of this Aggregate: The previous aggregates had the Pbar Sequencer operator cool the core frequency width to 15Hz. The VSA longitudinal profile SA should still be running on GxSC. This aggregate will ramp Accumulator bus supplies to the shot lattice. It then adjusts trombones, spectrum analyzer displays, emittance monitor local oscillators, and the stabilizing RF to their shot lattice settings. After this aggregate is complete, it will be time to move on to the **Run II Finsish Reverse Protons** aggregate which completes the 8 GeV beam line tuneup.
How to get back to stacking form here: If you have not run this aggregate, simply run the Run II Return to Stacking aggregate to return to stacking. If you have started this aggregate, then finish this aggregate and then run both the Run II Revert to Stack Lattice and the Run II Return to Stacking aggregates.

::: INSTRUCT 200



::: SHOT_LOG COMMENT

Enters the following comment into the Pbar portion of the shot scapbook at http://www-bd.fnal.gov/cgi-mach/machlog.pl?nb=scrap03.

Time- Accumulator switch to Shot Lattice. The Stack size is ##.#####. - Sequencer

::: ALARM_LIST PBar 44

Bypasses D59 list "ACC ANLG"

 Click on thumbnail image to view a full-sized version.

::: WAIT_FOR SECS 5 .

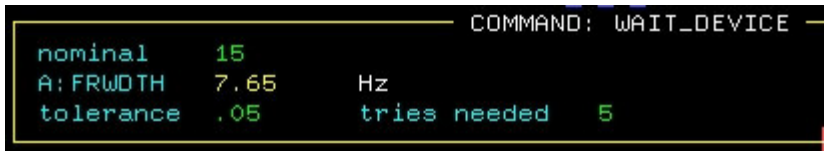
::: ALARM_LIST PBar 49 .

Bypasses D59 list "A Q SHNT"

 Click on thumbnail image to view a full-sized version.

::: WAIT_DEVICE A:FRWDTH .

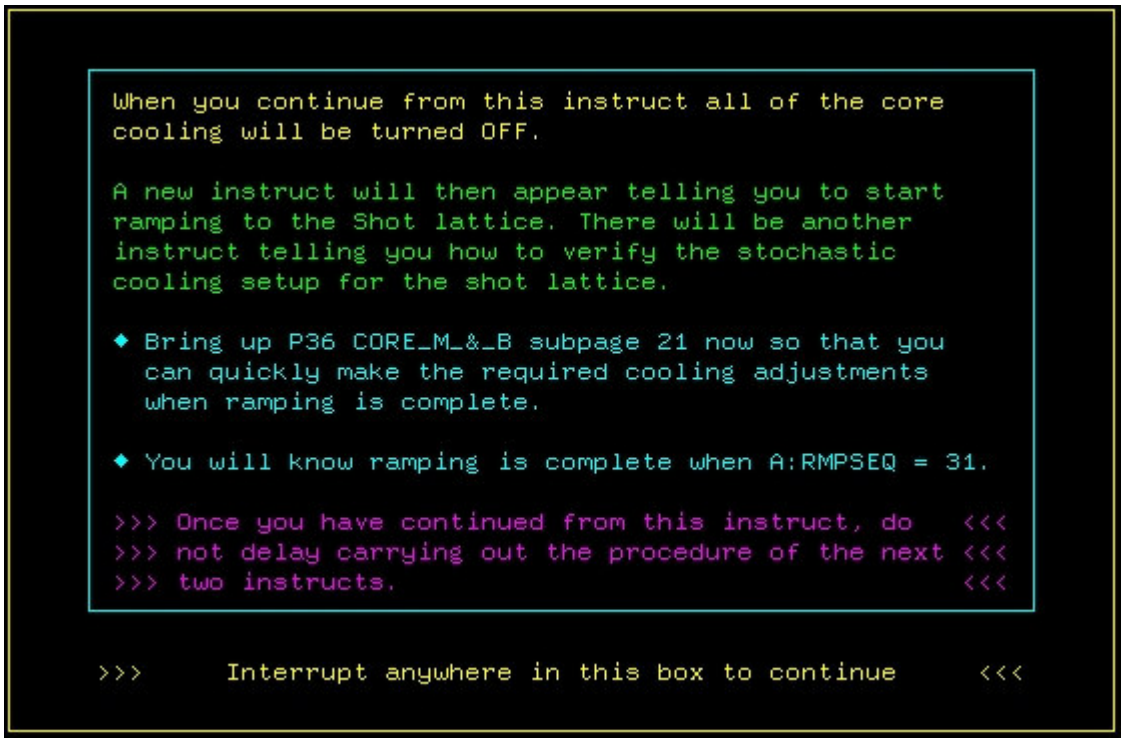
Waits for A:FRWDTH to get to 15 +/- 0.05 Hz.



::: CHECK_DEVICE A:FRWDTH SETTING .

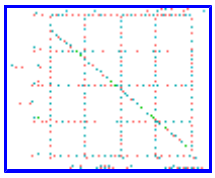
Verifies that A:FRWDTH is 14 +/- 1.00 Hz. Displays this information in the message window at the bottom of the sequencer.

::: INSTRUCT 204 .



::: AUTO_PLOT Shot Lattice .

Starts a FTP on your console of A:LQ (1170-1270 amps) and A:IBEAMB (0ma - current stack size) over A:RMPSEQ (0-32). This is the plot that the Pbar Sequencer Operator will watch when we ramp to the shot lattice. This plot will not have any data until we actually ramp to the shot lattice later in this aggregate.

 Click on thumbnail image to view a full-sized version.

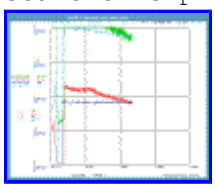
::: INSTRUCT 205 .

```
   You will be prompted to start a new Fast Time Plot of EMT3HN,
EMT3VN, FRWDTH, and CENFRQ with limits appropriate to the Shot
Lattice. Start this plot on an adjacent console, likely #2, and NOT
the 'SA' window! Keep an eye on this plot to ensure that transverse
emittances decrease and FRWDTH approaches its target, currently 22.
For large stacks in particular, it is okay if FRWDTH is not at its
goal, but it should be within a few Hz.

              Interrupt anywhere in this box to continue
```

::: AUTO_PLOT Core Emit Shot L .

Starts a FTP on the console of the operator's choice that contains A:EMT3HN (0-2 pi-mm-mrad), A:EMT3VN (0-2 pi-mm-mrad), A:CENFRQ (628920-628940 Hz) and A:FRWDTH (0-36 Hz) over time (0-1800 sec). Pbar Sequencer Operators normally start this plot on CNS2.

 Click on thumbnail image to view a full-sized version.

::: SETIT_DEVICE A:VSARST = 0 .

Changes the VSA Reset parameter from 5 to 0, which turns off the VSA momentum thermostat. We don't want the thermostat running when ramp to the shot lattice.

::: SET_SEQ FILE 33 .

File #33 turns off 2-4 GHz Momentum cooling and bypasses the alarms. We need to temporarily turn off the cooling while we ramp to the shot lattice.

```
A:CPPS01 TURN DEVICE OFF                                    ok
A:CPPS01 DIG_ALARM DISABLE                                  ok
A:CPTW01 ANA_ALARM DISABLE                                  ok
A:CPTW01 DIG_ALARM DISABLE                                  ok
A:CPHV01 ANA_ALARM DISABLE                                  ok
```

::: CTLIT_DEVICE A:CH1PS1 OFF .

The sequencer is almost ready to ramp Accumulator supplies to the shot lattice. The last thing that must be done is the cooling must be turned off during the ramp process. This command turns off the Pin Switch for Core Horizontal Band 1 cooling. The CTLIT_DEVICE command not only issues an off command to the device, but also waits a specified period and then verifies that the device is off. The following eight commands turn off other bands of cooling.

::: CTLIT_DEVICE A:CH2PS1 OFF .

This command turns off the Pin Switch for Core Horizontal Band 2 cooling.

::: CTLIT_DEVICE A:CH3PS1 OFF .

This command turns off the Pin Switch for Core Horizontal Band 3 cooling.

::: CTLIT_DEVICE A:CV1PS1 OFF .

This command turns off the Pin Switch for Core Vertical Band 1 cooling.

::: CTLIT_DEVICE A:CV2PS1 OFF .

This command turns off the Pin Switch for Core Vertical Band 2 cooling.

::: CTLIT_DEVICE A:CV3PS1 OFF .

This command turns off the Pin Switch for Core Vertical Band 3 cooling.

::: CTLIT_DEVICE A:CPPS01 OFF .

This command turns off the Pin Switch for Core 2-4GHz Momentum cooling.

::: CTLIT_DEVICE A:CMPS01 OFF .

This command turns off the Pin Switch for Core 4-8GHz Momentum cooling.

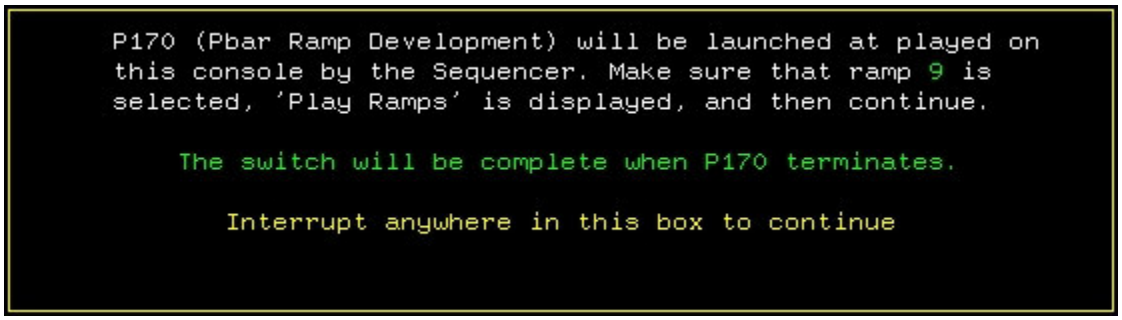
::: CTLIT_DEVICE A:CPTW01 OFF .

This command turns off the Core 2-4GHz Momentum TWT.

::: CTLIT_DEVICE A:R2LLAM OFF .

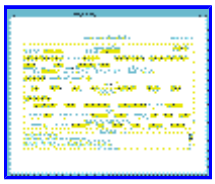
This command turns off the stabilizing RF (ARF2).

::: INSTRUCT 203 .

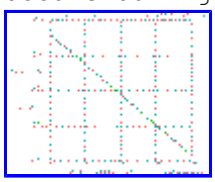


::: SEQ_PGM REQUEST Shot Lattice .

Program P170 is started and asked to play out file 9, which ramps Accumulator supplies from the stacking lattice to the shot lattice. The below screen capture shows P170 in action. When P170 has finished ramping to the shot lattice, the application will automatically close.

 P170 in action. Click on thumbnail image to view a full-sized version.

The below fast time plot shows ramping to the shot lattice. The x-axis plots A:RMPSEQ (0-32). P170 starts the ramp at A:RMPSEQ = 0, and increments the parameter by one for every ramp step. When A:RMPSEQ reaches 31, we have ramped to the shot lattice. The plot shows the ramp of the A:LQ power supply and also shows the Accumulator beam intensity at the top of the plot. If any beam is lost during the ramping process, it will be seen on this plot. A Pbar expert should be notified if any significant beam loss occurs during the ramp.

 Ramping to the shot lattice. Click on thumbnail image to view a full-sized version.

::: STEP_MOTOR A:CH1T2 297 .

Before the cooling can be turned back on, the trombones must be adjusted to their shot lattice values. This command moves the core horizontal band 1 trombone to its shot lattice value. The step motor command moves the trombone to its desired value using a feedback loop. The next seven commands moved other cooling band trombones to their shot lattice positions.

::: STEP_MOTOR A:CH2T2 338 .

This command moves the Core Horizontal Band 2 trombone to its shot lattice value.

::: STEP_MOTOR A:CH3T2 456 .

This command moves the Core Horizontal Band 3 trombone to its shot lattice value.

::: STEP_MOTOR A:CV1T2 415 .

This command moves the Core Vertical Band 1 trombone to its shot lattice value.

::: STEP_MOTOR A:CV2T2 218 D

This command moves the Core Vertical Band 2 trombone to its shot lattice value. This command is bypassed since there is a tunnel problem with this trombone that makes it very hard to move. As a result, this trombone is currently left at the stacking lattice value and not used during shots. As soon as a tunnel access becomes available, this will be fixed and again used during shots.

::: STEP_MOTOR A:CV3T2 239 .

This command moves the Core Vertical Band 3 trombone to its shot lattice value.

::: STEP_MOTOR A:CMTM01 252 .

This command moves the Core 4-8GHz Momentum trombone to its shot lattice value.

::: STEP_MOTOR A:CMTM01 236 D

This command is bypassed. If enabled, this command would move the Core 4-8GHz Momentum trombone to 236 psec.

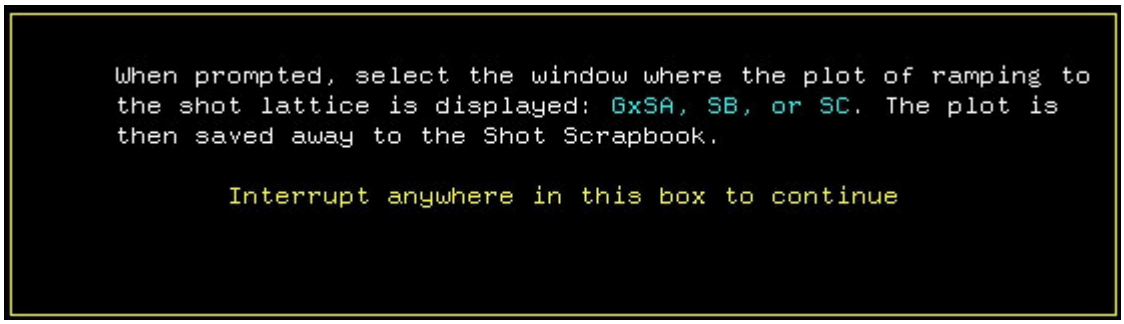
::: WAIT_DEVICE A:RMPSEQ .

Wait for A:RMPSEQ (PA1917 Ramp Sequence Parameter) to go from 0 to 31. When at A:RMPSEQ arrives at 31, we have completed our ramp to the shot lattice.

::: SETIT_DEVICE A:RLLFS0 =628930 .

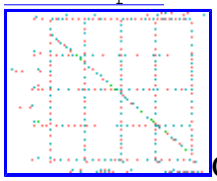
The core center frequency changes from 628886 Hz to 628930 Hz when we ramp from the stacking lattice to the shot lattice. This command sets the A:RLLFSO (ARF Synth Frequency) parameter to the shot lattice core center frequency 628930 Hz.

::: INSTRUCT 206 .



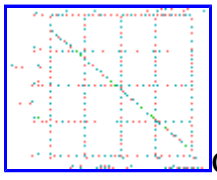
::: SHOT_LOG IMAGE .

Pastes a copy of the "shot lattice" FTP (started above)into the Pbar portion of the shot scrapbook at http://www-bd.fnal.gov/cgi-mach/machlog.pl?nb=scrap03


Click on thumbnail image to view a full-sized version.

::: COPY_SCREEN LCL SA .

Screen copy of the local SA window, which is the same fast time plot that the previous command copied to the shot log.


Click on thumbnail image to view a full-sized version.

::: CHECK_DEVICE A:RLLFS0 READING .

Displays present value of A:RLLFSO in the message window on the sequencer as shown below. The value of this device was set four commands earlier in this aggregate and should be 628930 Hz.

```
Mar-29-2005 05:36:29  COM: A:RLLFS0 present value = 628930.000000
```

::: SETIT_DEVICE A:RCETA = .025 .

The machine parameter η (Eta), sometimes called the "slip factor", is given by the equation

$$\eta = \frac{1}{\gamma_t^2} - \frac{1}{\gamma^2}$$ Equation (1)

where γ is the relativistic gamma and γ_t is the transition gamma. This value is determined by the lattice of the accelerator. Since we just ramped to the shot lattice, the value of η has changed. The VSA needs to know the value of η in order to make bucket area calculations. The "SETIT_DEVICE A:RCETA = 0.25" command sets the η parameter to its shot lattice value.

::: SETIT_DEVICE V:APSLAT = 2 .

V:APSLAT is a state parameter that is used to show the current lattice state of the Accumulator. V:APSLAT state 1 is the “stacking lattice”, and V:APSMOD state 2 is the "shot lattice." This command sets the V:APSLAT to the shot lattice.

::: SETIT_DEVICE A:VSARST = 1 .

This command restarts the VSA, so that the Accumulator center frequency A:CENFRQ is calculated after ramping to the shot lattice.

::: WAIT_DEVICE A:VSAAVG .

Waits for A:VSAAVG to be 1 for 15 consecutive samples.

::: SETIT_DEVICE A:R2LLAM = 1.65 .

This command sets the ARF2 stabilizing RF amplitude setting to 1.65 Volts. ARF2 is off at this point, but will be turned back on shortly. The actual output of ARF2 can be seen by looking at the ARF2 fanback voltage A:R2HLFB, and usually reads approximately 16 Volts at this setting.

::: CHECK_DEVICE A:CENFRQ READING .

When we ramped to the shot lattice earlier in this aggregate (see P170 ramp command above), the Accumulator center frequency changed from approximately 628886Hz to approximately 628930Hz. The VSA was restarted (see three commands earlier) and is used to calculate the center frequency A:CENFRQ. The "CHECK_DEVICE A:CENFRQ READING" command verifies that A:CENFRQ is near its expected frequency of 628930 +/- 5 Hz. If A:CENFRQ is out of tolerance, this command will display red error text in the message window indicating both the desired and measured center frequencies. If this command fails, verify that the VSA display program is running on GxSC.

::: SET_DEVICE A:CNFRQU A:CENFRQ .

Sets A:CNFRQU (Accumulator center revolution frequency unstacking parameter) to the current value of A:CENFRQ which is calculated by the VSA display running on GxSC.

::: SET_DEVICE A:R2DDS1 A:CNFRQU .

Sets stabilizing RF frequency to the core center frequency.

::: SET_DEVICE A:CNFRQU *= 2 .

....

::: SET_DEVICE A:R2CWFR A:CNFRQU D

....

::: CTLIT_DEVICE A:R2LLAM ON .

....

::: SET_DEVICE A:RLLFS0 A:CENFRQ .

....

::: SET_DEVICE A:RLLFS1 A:CENFRQ .

....

::: CHECK_DEVICE A:RLLFS0 READING .

The previous command ....

```
Mar-29-2005 05:37:03  COM: A:RLLFS0 present value = 628928.250000
```

::: CUSTOM COOL_GAIN .

Sets core cooling PIN attenuators to values obeying an equation *mult(i)* (A:IBEAMB)+offset(i)*. The constants "offset" and "mult" are stored in a table maintained by the AD\Pbar department. Custom cooling gain usually undershoots cooling power for larger stacks.

```
Mar-29-2005 05:37:03  COM: scaled gain settings with: 168.9183 * 1.0000
```

::: CTLIT_DEVICE A:CH1PS1 ON .

At the beginning of this aggregate, all of the Accumulator stochastic cooling was turned off (see turning off cooling commands above)so that the ramp to the shot lattice could be completed. The Accumulator supplies were then ramped to the shot lattice (see P170 ramp command above) and the Accumulator core transverse cooling system trombones were set to their shot lattice values (see the STEP_MOTOR commands above). It is now time to turn back on the transverse cooling systems by turning on their pin attenuators. The "CTLIT_DEVICE A:CH1PS1 ON" command turns on the core horizontal band one cooling. The next five commands turn on the other transverse cooling bands.

::: CTLIT_DEVICE A:CH2PS1 ON .

This command turns on the Core Horizontal Band 2 cooling.

::: CTLIT_DEVICE A:CH3PS1 ON .

This command turns on the Core Horizontal Band 3 cooling.

::: CTLIT_DEVICE A:CV1PS1 ON .

This command turns on the Core Vertical Band 1 cooling.

::: CTLIT_DEVICE A:CV2PS1 ON D

This command would turn on the Core Vertical Band 2 cooling, but it is bypassed. The Core Vertical Band 2 cooling currently is left off during the shot because there is a tunnel problem with the trombone for this band that makes it very hard to move. As a result, this trombone is currently left at the stacking lattice value and not used during shots. As soon as a tunnel access becomes available, this will be fixed and again used during shots.

::: CTLIT_DEVICE A:CV3PS1 ON .

This command turns on the Core Vertical Band 3 cooling.

::: SETIT_DEVICE D:FFTLOF =299.807 .

When we ramped to the shot lattice earlier in this aggregate (see P170 ramp command above), the revolution frequency changed. This means the location of the betatron sidebands also changed. The Accumulator 300MHz horizontal and vertical emittance monitors each have a hp8656B local oscillator that is tuned to the appropriate betatron sideband frequency via an Acnet parameter. The frequency control for the local oscillator responsible for the horizontal emittance measurement is D:FFTLOF. This parameter must be changed to its shot lattice value in order for the emittance readback A:EMT3HN to function properly. The local oscillator is located in the AP10 control room in rack B14R06 and is show below.

 Local oscillator for A:EMT3HN. Click on thumbnail image to view a full-sized version.

::: SETIT_DEVICE A:FFTLOF =300.197 .

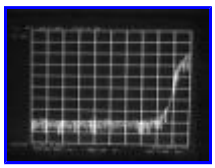
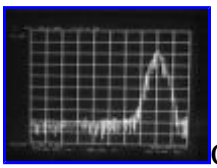
Likewise, the frequency control for the local oscillator responsible for the vertical emittance measurement is A:FFTLOF. This parameter must be changed to its shot lattice value in order for the emittance readback A:EMT3VN to function properly. The local oscillator is located in the AP10 control room in rack B14R06 and is show below.

 Local oscillator for A:EMT3VN. Click on thumbnail image to view a full-sized version.

::: SPECTRUM_LOAD 2 29 .

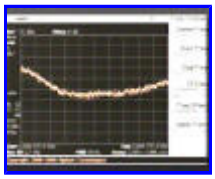
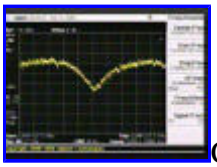
When we ramped to the shot lattice earlier in this aggregate (see P170 ramp command above), the Accumulator center frequency changed from 628886Hz to

628930Hz. As a result the Accumulator longitudinal display on CATV Pbar channel 28 is no longer centered. This is shown in the plot on the left below. This aggregate command loads P41 file 29 (Shot Lattice Display) into spectrum analyzer 2. This centers the plot as shown in the plot below on the left.

  Click on thumbnail images to view a full-sized versions.

::: SPECTRUM_LOAD 1 22 .

During shot setup, we use Spectrum Analyzer #1 to center the 4-8GHz pickups are centered on the beam. This can be viewed on CATV PBAR #20. P41 file #22 sets the center frequency of the spectrum analyzer to 84*A:RLLRS0. When we ramped to the shot lattice earlier in this aggregate (see P170 ramp command above), the Accumulator center frequency changed from 628886Hz to 628930Hz. As a result, if Spectrum Analyzer #1 was previously setup, the center frequency of the spectrum analyzer will no longer be correct, as shown in the plot on the left below. The "SPECTRUM_LOAD 1 22" command loads P41 file 22 (4-8GHz momentum Schottky at 5.5 GHz) into Spectrum Analyzer #1. This again sets the center frequency of the spectrum analyzer to 84*A:RLLFS0 as shown in the plot on the right below.

  Click on thumbnail images to view a full-sized versions.

::: SETIT_DEVICE A:C48RFQ =628928 .

Now that Spectrum Analyzer #1 is set to the correct center frequency, parameters are set to tell the VSA where to move the 4-8GHz momentum pickup array. The command "SETIT_DEVICE A:C48RFQ =628928" sets a parameter that tells the VSA where the approximate center frequency is located.

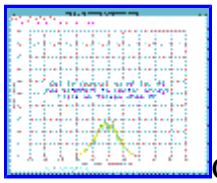
::: SETIT_DEVICE A:C48RPS =-45.97 .

This command sets the Core 4-8GHz reference position parameter. It tells the VSA that the correct 4-8GHz array position is -45.97mm for a reference frequency of 628928Hz.

Core 4-8 momentum reference position.

::: SETIT_DEVICE A:VSARST =3 .

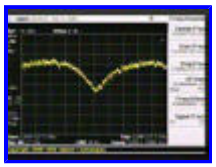
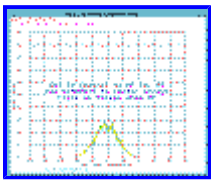
This command sets up the VSA for initial centering of core 4-8 momentum pickup arrays. Instructional text for aligning the 4-8GHz momentum pickups is added to the VSA application on GxSC as shown here.

 Click on thumbnail image to view a full-sized version.

::: WAIT_FOR SECS 20 .

::: INSTRUCT 208 .

Prior to turning on the 4-8GHz momentum cooling, we want to verify that the 4-8GHz pickup is centered on the beam. Start by going to P60 CORE_M_&_B < 3> (left screen capture below) and knob A:MARAYD to make the two humps on CATV PBAR #20 (middle screen capture below) equal in height. A negative knob on A:MARAYD makes the device readback more negative and moves the notch on CATV PBAR #20 to the right. Once the pickup is centered, click on the VSA display running on GxSC as shown in the screen capture on the right below. This action will set A:VSARST to zero, which is normal running without any thermostat. The VSA will be left in this configuration as we turn on the 4-8GHz momentum cooling in the next couple of commands.




Click on thumbnail images to view a full-sized versions.

::: WAIT_DEVICE A:VSARST .
When the Pbar Sequencer Operator clicks on the VSA display on GxSC, A:VSARST is set to zero. This ensures that the momentum thermostat is not running when we turn on the 4-8GHz momentum cooling.

::: CTLIT_DEVICE A:CMTW01 RESET .
This command resets the Core 4-8GHz momentum TWT #1.

::: CTLIT_DEVICE A:CMTW02 RESET .
This command resets the Core 4-8GHz momentum TWT #2.

::: CTLIT_DEVICE A:CMTW01 ON .
This command turns on the Core 4-8GHz momentum TWT #1.

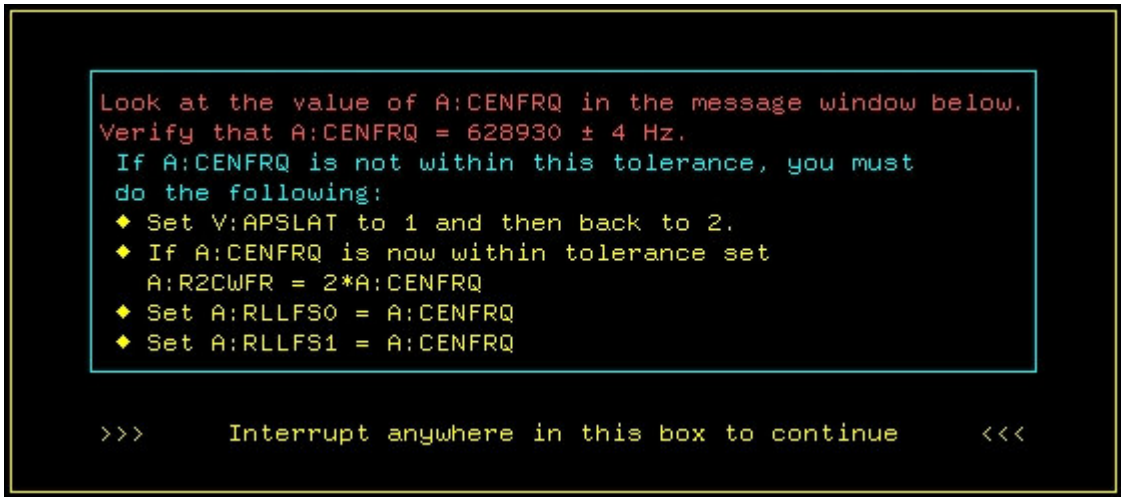
::: CTLIT_DEVICE A:CMTW02 ON .
This command turns on the Core 4-8GHz momentum TWT #2.

::: CTLIT_DEVICE A:CMPS01 ON .
This command turns on the Core 4-8GHz momentum pin switch. The 4-8GHz momentum cooling should now be on.

::: SETIT_DEVICE A:RLLEXF =628723 .
Sets the accumulator extraction orbit frequency.

::: SETIT_DEVICE A:RCFRV0 =628930. .
Dfrev0

```
::: SETIT_DEVICE A:VSAFWM =100      .
      Sets maximum accumulator frequency width.
::: SETIT_DEVICE A:VSAFWD =25       .
      Sets desired accumulator frequency width.
::: ACL SET_FROM_READING            .
::: SETIT_DEVICE A:DTMHVE =10       .
      Sets H-V emittance difference for VSA thermostating.
::: SETIT_DEVICE A:R4FSRL = 25      .
      Sets ARF4 frequency skew limit.
::: SETIT_DEVICE A:VSARST =5        .
      This command enables the Momentum thermostat.   The thermostat will attempt
to keep frequency width A:FRWDTH at the desired freuqency A:VSAFWD.
::: CHECK_DEVICE A:CENFRQ READING   .
      Checks A:CENFRQ and displays the value in the sequencer message box.
      Mar-29-2005 05:39:19  COM: A:CENFRQ present value = 628928.250000
::: INSTRUCT 212                    .
```

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ok  INSTRUCT 209                    .
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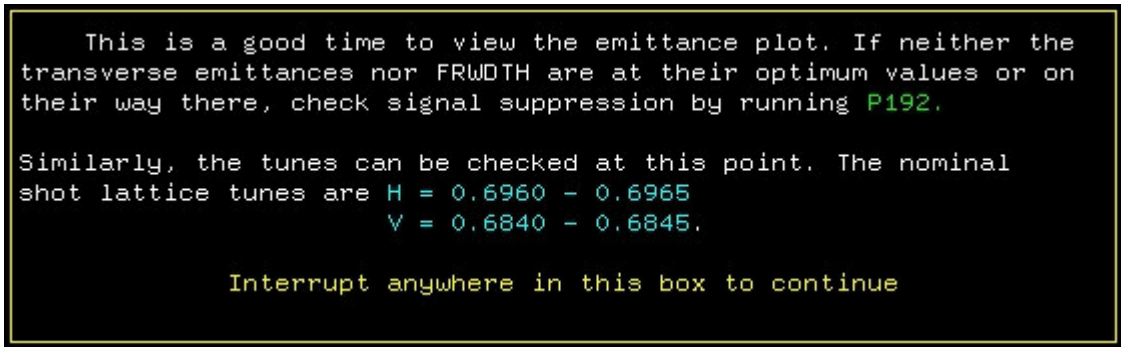
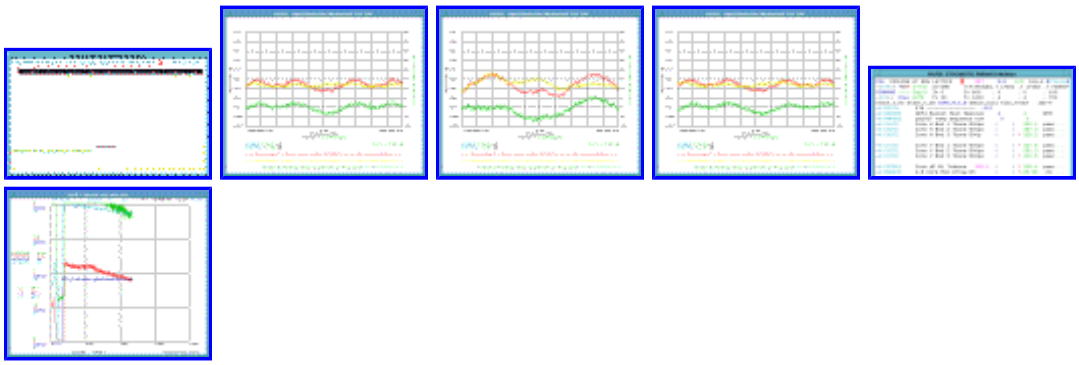


Measure the tunes with either P43, P44 or the Java application. When we ramped to the shot lattice earlier in this aggregate (see P170 ramp command above), Accumulator bus supplies changed, so it is possible that the tunes did not land back in the correct location in tune space. Always watch the rate of transverse cooling when making a tune change. The goal is to make the emittances cool faster. If the tunes consistently land too low or too high on consecutive shots, then make sure to make a note in the Pbar elog and contact a Pbar expert so that their ramp guru can adjust the ramps for future shots. The plot on the left show the result of a P43 tune measurement. The second capture shows P60 ACC50 <11>, where tune adjustments are made. The plot on the right shows the cooling plot that is normally running on CNS2.

If the emittances are not cooling after fixing the tunes, then a P192 signal suppression should be completed. The first screen is P192. From there, select a cooling band and start a measurement. The next three plots show sample signal suppression measurement results. If the peaks do not line up, trombones can be adjusted from P36 Core_M_&_B <21> as shown in the fifth screen below. The goal is to make the emittances cool faster, so again watch the cooling plot as shown in the sixth capture below. If a trombone adjustment is needed during the shot, then make a note in the Pbar elog and contact a Pbar expert so that their sequencer guru can adjust the trombones for the next shot.



Collider Aggregate: **Run II Switch to Shot Lattice** has been completed.
Next Aggregate: Run II Finish Reverse Protons
How to get back to stacking form here: If you have not done so, finish this aggregate and then run both the Run II Revert to Stack Lattice and the Run II Return to Stacking aggregates.